Great Plains Regional Assessment

Chap 4.3 Ranching & Livestock Report

Effects of Climate Change on Quantity/Quality of Vegetation

Climate change is likely to affect both the quantity and quality of rangeland vegetation. The structure and function of grasslands are largely a function of wa and temperature. For instance, Great Plains grasslands transition from short-gr steppe to mixed prairie and finally tallgrass prairie as one travels west to east fr the Rocky Mountains to the eastward extension of the Great Plains. This transiti corresponds to a precipitation gradient from areas of low rainfall on the east sid of the Rockies to areas of relatively high and more evenly-distributed rainfall in t tallgrass prairie region. At the same time, the temperature gradient from norther to southern Great Plains regions represents another important gradient that determines plant type distribution and local abundances (e.g., warm-season vs. cool-season grasses).

Climate change, caused by increased CO2, will likely result in altered temperatu and precipitation. These three environmental parameters will likely affect Great Plains grasslands, primarily through their effects on plant and soil water relatior photosynthesis, and other aspects of plant metabolism. Secondary responses tl are likely to affect the long-term responses of grassland ecosystems to climate change will involve effects on soil carbon and nitrogen cycling. Responses will result from direct effects of the changing environment on individual plants (e.g., productivity), as well as from changes in plant communities which occur due to different sensitivities of individual species to climate change. One example of a CO2 effect that may already have contributed to altered plant community structu is the conversion of southwest rangelands from systems dominated by warm-season grasses to a shrub-dominated system. Response of the shrubs to CO2 enrichment may have played an important role in this phenomenon (Polley 1992] Likewise, an increase in the minimum temperature in the spring has been correlated with a decrease in the net primary productivity of Bouteloua gracilis (grass) in the shortgrass steppe, and with increases in exotic and native C3 forbs

/8

ADMIN RECORD

SW-A-006038

undesirable annual grasses and forbs over current dominant perennial vegetatio (Polley 1992). Though other factors, such as grazing management and fire suppression, have also contributed to increased woody encroachment of grasslands (Archer 1994).

Some changes, like enhanced forage production in response to elevated CO2, m be beneficial. Changes in seasonality of all biological organisms due to possible warmer and longer growing seasons will have profound impacts on the ecology grasslands. However, this direct effect on forage production may be overshadov by changes in the balance of current dominant warm- and cool-season grasses, increased composition of legumes, or increased shrubs. Other factors related tc climate change may also have a bearing on forage quality. Changes in forage quality from climate change may be either positive or negative in terms of nutriti value for domestic livestock, and negative changes may be overcome to some extent by greater intake of forage.

Fire in the Great Plains has been largely suppressed since the area has been cropped. Under climate change conditions, the frequency and severity of weathe conducive to fire may increase. Likewise, changes in plant communities caused climatic changes may alter the physical and chemical properties of fuels (Ryan 1991). Therefore, fire potential in the region will be impacted by climate change. There is evidence of increased historically significant fires already in the last twelve years (National Interagency Fire Center 2001).

Large areas of the land in the Great Plains have been converted from native prai to cropland and other land uses. Livestock enterprises are often a mix of range management, planted forage, and crop activities. Rangelands may be more resilient than croplands to climate changes, since the internal structure of soil ai plant communities is maintained, whereas with traditional management of croplands, intensive inputs are required to maintain soil productivity, minimize s erosion, and replace vegetation annually. However, there are still some livestock operating systems that may not be very resilient.

To deal with these changes in climate and climate variability, the following copin strategies will be important.

1) Land Conversion/Change in Enterprise

A good example of land conversion or a change in enterprise might involve wate which is viewed as the major determinant of agricultural practice in the Great Plains. If climate changes are significant enough to alter the agricultural potentia of a region due to changes in growing season water availability, then there will b pressure to convert land in the direction dictated by that change (e.g., rangeland cropland, rangeland to improved pastures, or vice versa). A change in enterprise another possible response to climate change, such as using new livestock breec developed for specific conditions (e.g., more heat-adapted species), increased o decreased reliance on improved pastures for supplemental grazing, improved or better-adapted forages for supplemental grazing, or enhanced pest and disease resistance. Some changes in vegetation management associated with climate might be subtle. For example, the recent summer of increased humidity experienced in the eastern Great Plains delayed haying operations as the plants were often too wet early in the day to harvest.

2) New/Improved Grazing Systems

On rangelands in which management is relatively extensive and input costs minimal, management of domestic livestock has been and remains one of the major coping mechanisms to deal with the climate variability of the Great Plains

Various rotational, prescriptive, and season-long grazing strategies are availabl and need to be evaluated in terms of their performance under climate change, including their sustainability, economics, and capability to store carbon. These strategies involve:

- number of animals
- species/class of animals
- rest/rotation grazing systems
- distribution/concentration of animals
- complementary pastures improved pasture development

3) Efforts to Understand Pest/Disease Vectors

Climate change may involve environmental perturbations (drought, flood, temperature) that are likely to affect life cycles of various pest/disease organism and could exacerbate problems due to outbreaks. For instance, grasshoppers a sensitive to wet/dry periods, although this sensitivity is quite variable among species of grasshopper. Possibilities of increased rust on native grasses under higher humidity patterns, such as was experienced in the eastern Great Plains in recent summer, may increase if ambient humidity increases. Our present ability predict the relationship between these pest outbreaks is limited and patterns of outbreaks may change in future environments in ways that are not predictable fr our present knowledge. Efforts are needed to understand how climate change w impact such outbreaks, and what managers can do to plan or deal with them.

In regards to possible producer responses to climate change and coping strategies, the group stressed the importance of having in place incentives that would promote sustainable management systems, including practices that lead increased soil organic matter, carbon sequestering, and efficient use of water.

4) Efforts Need to be Made with Land Managers to Recognize Function and Heal of the Ecological Processes

The effective functioning of the water, various nutrient and energy cycles, as wel as plant community succession, can buffer both long and short-term impacts an cycles of weather and climate fluctuations. For example, if a grassland commun is allowed by management to be diverse with abundant vegetative cover that supports an extensive fibrous root network, then soil permeability is increased, compaction decreased, and the soil surface protected from erosion. The recipro would be a community of low diversity, surface compaction, and bare surface s that would result in unstable watershed hydrographs, soil erosion, and water quality degradation. Invasive species and brush encroachment into rangelands r also be a problem under climate change. Likewise, as discussed earlier, fire regimes and potential will be altered under a changed climate. This will have impacts on ecosystem function and health. In short, management toward health effective ecological function is essential in the buffering of long-term climate changes.

Effects of Climate Change on Domestic Livestock

Climate change will likely affect domestic animals both indirectly and directly. F example, alterations in forage production may have indirect effects on animals. most obvious direct effect will be caused by temperatures, since both hot and c temperatures already impose important limitations on livestock operations. If humidity increases, this could exacerbate the problem of high temperatures for livestock. If significant changes in precipitation patterns develop, then those too

Specifically, Hahn and Morgan (1999) report that climate change impacts will reduce summer season production, reproduction, and efficiency of domestic animals. Increased incidences of extreme events, such as heat waves, are also expected to not only reduce performance, but may also result in death of more vulnerable animals. Following are some coping strategies.

1) Mix or Change Animal Species and/or Breeds to Suit New Environmental Conditions

Cattle, bison, sheep, goats, etc. have different adaptabilities to the environment, do breeds within species. These differences should be considered in regard to tl changing environment, in order to match grazer species with the plant communities that result from change. This also applies to the possibility of including more than one species in a grazing operation.

2) Change Timing of Events

The timing of important events in the raising of livestock, such as calving, lambii and weaning, could be modified in response to a changing climate.

3) Lessen Stresses

Where climate change results in more stressful environments, production practices will need to shift away from stressful environments (e.g., intensive operations) or practices will need to be modified in stressed environments (e.g., lower livestock numbers on water-stressed rangelands; reduce environmental h loads by using shades, sprinklers, or other means during the summer).

4) Monitor Pests/Diseases

As with plants, climate change will likely perturb pests/diseases of domestic livestock (e.g., hornflies, brucellosis), and management practices will need to be developed to counter these problems (Rosenzweig and Hillel 1995).

Effects of Climate Change on Wildlife Populations

For many of the reasons stated above, climate change will impact all species of wildlife, including insects, birds, fish, amphibians, reptiles, and large and small mammals. In addition, it is known that agricultural practices also have importan effects on wildlife populations. Coping strategies include integrated managemer strategies for wildlife. This involves determining and adopting management strategies and systems that are directed towards maintaining appropriate levels quality wildlife. This is a cross-cutting issue that will involve management of domestic animals, crops, water and land use practices, and will require community-wide collaborations to maintain or restore appropriate wildlife habit in addition to the more usual producer concerns. Issues to be addressed include habitat fragmentation and wildlife corridors, changing hydrological regimes, rur and urban development, and the use of chemicals and other new technologies th may impact wildlife or their habitat. An important matter will be how to achieve t in a manner that engenders support from all concerned.

Extreme Events

In addition to a change in climate and the effects on plants and animals discusse above, climate change may also bring about changes in both the frequency and

severity of extreme events that may impact grazing lands and intensive livestock operations. Although the ranching and agricultural economies have proven resili to historic extreme events, the toll on individual producers has been heavy and remains memorable. The key issue is the possibility that these extreme events, l drought, would occur in greater frequency and/or for longer durations, so that instead of a one year drought there might be a 2 or 3 year drought on more frequent cycles. Producers agreed that three bad years could wipe out even a w capitalized producer. Feedlot operators need to be aware of the dynamics of animal responses to heat waves and to plan strategically for an increase in heat waves, so that when a heat wave is forecast, they can implement specific coping strategies such as wetting animals, providing shade, or making diet adjustments Several consecutive days of hot temperatures can result in large numbers of animal deaths, especially in intensive systems. Coping strategies include:

1) Appropriate Insurance Coverage

This insurance on both forage and livestock will be needed to cope with drought floods, and other extreme events.

2) Increased Feed Reserves

These reserves may include harvested forages and using grazing reserves as a buffer against extreme events (e.g., CRP, commons areas that are grazed only during harsh environmental periods of low forage supply).

3) Enterprise Diversification

The group felt that diversified systems would be better able to withstand extrem weather events. In a general sense, this supports rangeland systems as a viable management option, as these systems are composed of numerous species with wide range of adaptabilities to respond to extreme events. Rangeland systems a represent a less-disturbed state compared to croplands, and are likely to be less sensitive to extreme weather events (e.g., the Dust Bowl of the 1930s). This woul be an argument for preserving rangelands and not converting them to croplands But this philosophy can also be directed toward multiple enterprise agricultural systems, including agronomic systems that incorporate several crops, and perhaps grazing animals, as components.

4) Improved Weather Forecasting

The system in Queensland, Australia was offered as an example to emulate. The state government there supports communication among meteorologists, agriculturalists, and producers that results in the latest weather data being scrutinized and used in simulation exercises to assist producers in real-time management decisions. This could be extremely useful if future environments become more variable or harsh.

5) Increased Water Reserves

Water reserves may become more important if future climate is characterized by more severe summer droughts.

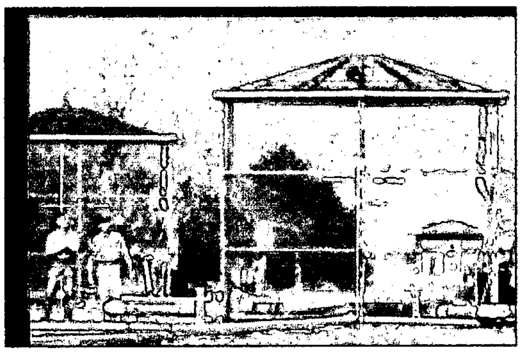
The rangeland and livestock group also discussed some future climatic and economic/policy scenarios, and coping strategies to deal with these changes. Th discussion of these scenarios is included in Appendix D.

Box

Physiological Responses of Grasses to Increased Atmospheric Carbo Dioxide

Research conducted in large open-top CO2 enrichment chambers on shortgrass steppe vegetation in north-eastern Colorado has provided scientists from USDA ARS and Colorado State University with insights into how elevated CO2 will effe productivity and ecology of these grasslands (Fig. 1). The site contains a mixtur mostly warm- and cool-season grasses, and is representative of much of the vegetation found in the Great Plains. The CO2 level in three of the chambers is maintained at 720 parts per million, twice the concentration in the other three chambers which are maintained at the present ambient level of 360 parts per million CO2. Current models project that atmospheric CO2 concentrations will increase above 720 parts per million before the end of the 21st century.

Aboveground productivity of native grasses and forbs has been consistently enhanced in the chambers under double ambient CO2, as indicated by increases aboveground peak



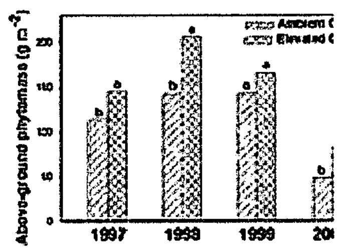


Figure 1: Open-top CO2 enrichment chambers on the shortgrass steppe in north eastern Colorado.

Figure 2: Above-ground productivity increased with elevated CO2 as measured I above-ground phytomass

phytomass ranging from 20% to 71% (Fig. 2). The greatest relative increase (71% occurred in a dry year (2000) in which production at peak standing crop was abo half of the long-term average for the site. However, protein concentrations tend 1 be lower under elevated CO2, so while forage production may go up in future CC enriched environments, forage quality may decline. After four years of CO2 enrichment, no relative differences in growth responses to CO2 have yet been detected between warm- or cool-season grasses. These results on the CO2 effec alone need to be evaluated in regard to the changing climate, but suggest important changes in the ecosystem that will affect management strategies. One particular issue will be the possible need for supplemental nitrogen to maintain forage quality in future CO2-enriched environments.

End of Box

Box

Extreme Events

Climate change may bring about changes in both the frequency and severity of extreme events (droughts, floods, heat waves, winter storms) that may impact agriculture, grazinglands, intensive livestock operations, natural systems, hydrologic systems, and human communities. Although the ranching and agricultural economies have proven resilient to historic extreme events, the toll (individual producers has been heavy and remains memorable. The key issue is t possibility that these extreme events, like drought, would occur in greater frequency and/or for longer durations, so that instead of a one year drought ther might be a 2 or 3 year drought on more frequent cycles. Producers agreed that three bad years could wipe out even a well-capitalized producer. For natural systems, frequent extreme events could lead to extinctions if populations (flora ; fauna) do not have sufficient time to recover from the perturbations. For hydrolo systems, the management of dams and water containment systems may need tc reconsidered given the possible changes to historic flood and drought periods. Coping strategies include appropriate crop and livestock insurance coverage to deal with droughts, floods or other extreme events and increased feed reserves including harvested forages and using grazing reserves as a buffer against extre events (e.g., CRP, commons areas that are grazed only during periods of low forage supply) for the livestock sector. Enterprise diversification could also be a way to cope with extreme events, as diversified systems would be better able to withstand extreme weather events. Improved weather forecasting could also ass producers in real-time management decisions. Water reserves may also need to increased if future climate is characterized by more severe summer droughts. Likewise, for human systems better preparedness to react to extreme events quickly and efficiently will be important for successful coping.

End of Box

Click here to download water(pdf version) >>

Back to Chapter 4>>

On behalf of the entire GPA group, thank you again for your interest in GPA. If y have any question about the GPA, please contact our webmaster.